1. Intr duction and Ov rview

In the office action Claims 1-3, 5-10 and 12 were rejected; Claim 4 was objected to; Claim 11 was allowed. Dependent Claims 2,3,5-7, 9 and 10 were rejected under 35 U.S.C. 112, paragraph two, as being indefinite.

Claims 1 and 8 were rejected under 35 U.S.C. 102(b) as anticipated by or, alternatively, under 35 U.S.C 103(a) as obvious over **Slate et al. (4,919, 596)**. Claim 1 was further rejected under §102(b) as being clearly anticipated **by Hampton et al. (5,269,659)**. Claims 2,3,5,6 and 8 were rejected under §103(a) as being unpatentable over **Hampton et al**. Finally, Claim 12 was rejected under §103(a) as being unpatentable over **Slate et al.** or **Hampton et al**.

A brief summary of **Slate et al.** and **Hampton et al.** is as follows:

Slate et al. teaches a feedback controlled fluid delivery and control apparatus incorporating a DC motor and a piston pump embedded into a disposable output cassette for delivering fluid to a patient. The piston pump is driven at intervals depending on feedback from drive sensors, the output cassette and monitoring means. Control of motor speed is via a controller which computes "the motor voltage pulse width based on feedback information from an encoder" (column 3, lines 61-64).

Hampton et al. teaches a DC motor-driven diaphragm pump with a closed loop servo control system for maintaining constant fluid flow through the pump (see **Hampton et al.** column 1, lines 51-53). As regards the input to the pump motor, it is stated in column 3 lines 20-22 that "The speed of pump motor operation is related to the duty cycles of the pulses applied to the windings thereof." This clearly indicates that the pump motor in Hampton et al. is a DC motor where the speed is determined not by motor driving supply frequency but by the effective DC current through the motor, which results from and is proportional to the applied pulse width.

The motor-pump in Applicants' disclosure is a permanent magnet AC synchronous motor pump which cannot be controlled by simply varying the effective applied voltage by pulse width modulation as in the disclosures of **Slate et al.** or **Hampton et al**. Worthy of note is that DC motors do not generally respond to a varying frequency of an AC drive in any predictable manner.

Novelly, applicants' ***combination*** of motor driving supply frequency control ***and*** Pulse Width Modulation control are used to considerably extend the working speed range over which an AC synchronous motor pump can be usefully varied.

Before addressing the specific reasons for rejection in the office action, it is first necessary to address the issue of DC motors versus AC synchronous motors as recited on page 3 section 5 of the office action. ('office action' is further referred to as 'OA' in this amendment),

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2. That the Applicants Teach an AC PMSM and not a Brushless DC Motor as Stated in the Office Action (OA Section 5)

In Section 5, page 3 of the office action a classification of DC motors is given wherein DC motors are classified as falling into one of two categories - either *brush type* (type a) or *brushless type* (type b). A definition of each type is then given.

To quote the definition of a brushless dc motor (type b) as recited in the OA:

> "Brushless dc motor. This type of motor has a permanent magnet rotor and a stator with phase windings. This motor requires an electronic commutation, a rotor position sensor and an inverter controlled by the signals from the rotor position sensor. The motor

speed/torqu can be controlled by the frequ ncy of the pulse width modulation of the inverter, therefore, this is a synchronous motor."

Examiner gives no authority for this definition. As defined above, a DC motor of type b is **not** a synchronous motor. Controlling the "frequency of the pulse modulation" is not equivalent to controlling the frequency of the signals applied to the motor windings. Rather, such control, as in the definition above, produces an effective DC voltage (a DC voltage applied with an effective duty cycle) applied to the motor windings which in turn affects the speed of the DC motor. This by itself does not and can not produce synchronization.

Based on the above definition given by the Examiner, the Examiner concludes (OA section 5 last paragraph) that "The so-called 'AC permanent-magnet synchronous motor' (or AC PMSM) defined by applicants is actually a brushless dc motor of the type b above."

Synchronous motors are well known in the art to be **AC** and not DC devices. For example in Walker, P., Ed (1988) Chambers Science and Technology Dictionary. Chambers/Cambridge. New York. pg 878, a synchronous motor is defined as an "A.c. electric motor designed to run in synchronism with supply voltage." Such motors retain synchronization with the **frequency** of the voltage applied to the motor. For two pole synchronous motors the speed of the motor is equal to the frequency of the source. Beyond extremely narrow frequency limits, synchronous motors either run at the source frequency or stall. The present invention overcomes such a limitation and considerably extends the controllable speed range of an AC PMSM pump.

By definition a DC motor utilizes **commutation,** i.e., a mechanism by which the magnetic field direction (rotor or stator) is switched in a strict phase relationship to the mechanical position of the rotor. This commutation may be either electronic using a rotor position sensor to provide a switching signal to an

electronic means of switching (transistors, FETs, IGBTs etc.) (OA type b) or may be purely mechanical as in the case of a conventional segmented commutator/ brush motor (OA type a).

In the disclosure an AC synchronous motor is described. For this type of motor there is no commutation and magnetic field switching is derived without any feedback mechanism from the rotor. It is important to realize that a fundamental feature of an AC synchronous motor is the reliance of the motor speed upon an **externally** derived AC signal **frequency** and *not* upon the applied voltage.

Very clearly, neither **Slate et al.** nor **Hampton, et al.** teaches or suggests a synchronous AC motor nor for that matter any AC motor. Their disclosures are confined to DC motors and no contention of the Examiner can make them into AC motors as claimed. In contradistinction, applicants' AC motor pump control is not met by the disclosures of the cited patents. The claims herein are clearly patentable over the cited references.

Examiner's position amounts to the application of hindsight, and, in effect, drawing upon applicants' disclosure to supply what is missing in the two applied references. The Federal Circuit has sternly cautioned against the use of hindsight in determining whether an invention was obvious in light of prior art as of the date of the invention. Panduit Corp. v. Dennison Mfg. Co., 774 F.2d 1082, 227 USPQ 337, 342 (Fed. Cir. 1985). See also Zurko, F.3d, 887, 42 USPQ2d 1476 (Fed. Cir. 1997).

3. Rejections of Claims 2, 3, 5-7, 9 and 10 under 35 U.S.C. 112, Paragraph Two Are Overcome (OA Section 2)

Applicants have canceled Claims 5 and 6. Claims 2, 3, 7, 9 and 10 remain under consideration as regards §112 rejection. These claims were rejected in part

based on improper dependency or other indefinite problems. Claim 2, 3, 7, 9 and 10 have been amended to overcome problems regarding antecedent basis. Claims 4 and 8 have also been amended to overcome a problem with antecedent base in light of the modified preamble of amended Claim 1. New dependent Claim 13 has been added to overcome a problem with antecedent base in un-amended Claim 9.

4. Rejections of Claims 1 and 8 under §102(b) and §103(a) Over Slate et al. are Overcome (OA Section 5)

Applicants have amended Claim 1 to more clearly annunciate the novel and non-obvious features over Slate et al. and to further differentiate over the prior art. However, the arguments to be forwarded apply in major part to the claim language objected to in the OA some of which still appears in the amended Claim 1.

In the OA it is stated that the Slate et al. Fig. 3 shows a pumping cycle which is a "predetermined manner." This is a strained interpretation of "predetermined manner" as written in un-amended Claim 1. The pumping cycle in Fig. 3 refers to a complex fill cycle of a cassette involving inlet and outlet valves. This bears at best a strained relationship to "varying the flow rate of a pump" as in Claim 1. The OA also refers to Slate et al. Fig. 5 which shows a "rate command" which is stated as "another 'predetermined manner'." The rate command 104 in Fig. 5 - a block diagram of the delivery rate control system - is also a strained interpretation of "predetermined manner" as relates to Claim 1. The rate command in Slate et al. is actually an internally generated value as part of a feedback control system to control the filling of the cassette. It is not "predetermined" but depends on dynamic inputs from drive sensors, the output

cassette and monitoring means. Thes constitute strained interpretations of Slate et al. and argue against an obviousness rejection under §103(a). Nevertheless, in amended Claim 1, applicants have replaced "predetermined manner" with more limiting language to overcome Examiner objections to any potential vagueness in "predetermined manner" as recited in Claim 1.

In the OA, Slate et al. Fig. 5 is also referenced with respect to a "microprocessor 70 and pulse generator 78: a signal 'PULSE WIDTH' is inputted to the pulse generator 78." In Slate et al, simple pulse width modulation is employed wherein pulse width and **not** frequency is varied. Even if Slate were to vary frequency, it would have no meaning in the Slate case, as Slate is controlling a DC not an AC motor.

Applicants note that for an AC PMSM and varying pulse width **alone** (i.e. maintaining a constant drive frequency over a range of pulse widths) would not cause the motor to lose synchronization (i.e. it would still run at a speed synchronized with supply frequency), but that outside this range the motor would slip, stall or otherwise unpredictably fail to stay in synchronization. In other words, the motor, by variation of pulse width alone, would not have variable speed as in the DC motor case in Slate, et al. Applicants' control clearly cannot be anticipated from the Slate et al. DC control.

Further, Slate et al. does not teach what the Examiner is relying on to support rejection based on §103(a). Claim 1 is clearly allowable over the Slate et al. Claim 1 recites a micro controller with means calculating the pulse width **and** frequency timing for generating pulse switching signals to control the motor pump. As is noted above, simply controlling pulse width for an AC synchronous motor would have no effect on motor speed. It has been previously shown in Section 2 above that applicants' motor is *not* a DC motor. Claim 1 is novel since it recites the variation of the **combination** of pulse width and frequency to control the speed of the motor pump which extends the flow range of operation of the AC

PMSM pump. This differentiates not only for the instant DC cas (for which frequency variation would have no benefit) but also differentiates over the prior AC PMSM art.

Claim 1 is further non-obvious over Slate et al. since controlling frequency would have absolutely no effect on the speed of the Slate et al. DC motor. Consequently, Slate et al. does not teach what is relied upon as the basis for a §103(a) rejection.

Finally, it is stated in the OA that "Slate, et al. teach 'DC motors' (see column 3, line 37, for example) and 'pulse width' (see column 6, line 48, for example. These together show that Slate's motor is an AC PMSM as defined by applicant." The arguments above show that the combination of pulse width and frequency (elucidated in Claim 1) while being advantageous in the case of controlling an AC PMSM pump, are of no benefit in the DC case of Slate et al. Examiner is relying on what Slate et al. do not teach in basing a §103(a) obviousness rejection of Claim 1. Based on the applicants' arguments in Section 2 above, applicants' motor is an AC synchronous motor and Slate et al. teaches a DC motor. To repeat, while pulse width modulation can control a DC motor as in Slate et al., pulse width modulation **alone** cannot control the speed of an AC synchronous motor as recited by applicants and elucidated in Claim 1.

Nevertheless, applicants have amended Claim 1 to more specifically overcome Examiner objections and to more clearly spell out the unique features of the invention. Amended Claim 1 specifically limits to AC permanent magnet synchronous motor (PMSM) pumps. Further, amended Claim 1 language spells out in more limiting language the calculation of frequency and related pulse width and specifically calls out an AC signal - which more clearly differentiates from the prior art.

Regarding Claim 8, Claim 8 recites a "line receiver/transmitter for interfacing an external data input/output signal to said micro-controller". This is

novel and overcomes §102(b) rejection in that said micro-controller can communicate dynamically *both ways* with an external device to affect control of the motor pump. One example of such an interface is with an external DMX controller operating outside of the controller environment. Slate et al teaches no such interface and such interface cannot be anticipated from the reference.

Examiner states that Slate et al Figs. 1, 2 and 5 all show input "commands" and that these commands receive input information via various means including a key pad, an input knob or potentiometer. Examiner states that "these input knob, potentiometer, keypad are line receiver/transmitter interfaces." Slate et al. does not teach what examiner is relying on to base a §103(a) rejection. In Slate et al. these input "commands" fix parametric values to govern the feedback control system that controls the filling of the cassette. The line receiver/transmitter of Claim 8 receives external dynamic values which are used to dynamically change the output of the motor pump directly *and transmit such changes back to the external device.*

5. Rejection of Claim 1 under §102(b) Over Hampton et al. is Overcome (OA section 6)

Examiner rejected Claim 1 as being clearly anticipated under §102(b) by Hampton et al. Hampton et al. teaches a DC motor-driven diaphragm pump with a closed loop servo control system for maintaining *constant* air flow through the pump.

Applicants teach an AC synchronous motor which cannot be controlled in the manner taught by Hampton et al. Applicants' Claim 1 is not anticipated under §102(b) by Hampton et al. for the following reasons: Claim 1 and amended Claim 1 recite a novel manner of controlling an AC synchronous motor (see Section 2, above) and not a DC servo controlled motor. It makes no sense to

control the DC motor of Hampton et al. in the manner annunciated in Claim 1. There is no feedback control in applicants' Claim 1 or amended Claim 1. Feedback in Hampton et al. is provided to maintain constant not varying flow from the pump as in Claim 1 and amended Claim 1. The OA references Fig. 1 of Hampton et al. with flow rate reference 121 and timer 118 as constituting alone or together a "predetermined manner." Relying on feedback elements - flow rate reference 121 and timer 118 - as constituting a "predetermined manner", is clearly a strained interpretation of "predetermined manner" as recited in Claim 1.

Examiner notes that Hampton et al. vary pulse width and frequency and refers to column 4, lines 47-49 which state:

> "The *pulse width modulator* used to implement pump motor drive circuit **123** produces pulses of predetermined frequency and a nominal width." *(italics, applicants)*

The "frequency" referred to in Hampton et al. is the frequency input to the pulse width modulator (which varies duty cycle) and is not equivalent to "frequency" as in Claim 1 and amended Claim 1 which is used for synchronous drive. Hampton et al. does not teach what is relied upon in OA regarding a potential §103(a) rejection.

Fig. 2 in Hampton et al. shows a flowchart of a feedback control system to maintain constant pump output. That Claim 1 and amended Claim 1 both recite a "programmable" micro controller and Hampton et al. indicates programmability of a feedback control system is at best a strained interpretation of "program" or "programability."

Examiner points out that a switching circuit in Hampton et al. is inside drive circuit **123**. While there is a pulse width modulator inside drive circuit **123**, this is not an "output switching circuit" as enunciated in Claims 1 and amended Claim 1.

In the OA (page 5, first paragraph) Examiner notes that Hampton et al. repeatedly teach "pulse width". Applicants have no disagreement with this. However, Examiner's contention that "These all together indicate that Hampton et al. motor is an AC PMSM as defined by applicant." constitutes a misreading of Hampton et al. The Hampton et al. motor is a DC servo-controlled motor and is not an AC device. Hampton et al. is controlled by the output of a pulse width modulator which outputs a pulse of variable duty cycle which is converted within the motor to an averaged effective DC current by which the speed of the motor is controlled. Claim 1 and amended Claim 1 enunciate the calculation of **both** pulse width **and** frequency to control the motor pump. Using similar arguments as described in Section 4, controlling frequency as in Claim 1 and Claim 1 (amended) would be essentially meaningless in the Hampton et al. case. Claim 1 and amended Claim 1 are novel over Hampton et al. because controlling both frequency and pulse width would make no sense in the Hampton DC pump motor as simple pulse width modulation would suffice to control motor speed.

Clearly, amended Claim 1 is allowable over Hampton, et al.

6. Rejections of Claims 2,3,5,6, and 8 under §103(a) Over Hampton et al. are Overcome (OA section 7)

Applicants have cancelled Claims 5 and 6. Objection to Claims 2, 3 and 8 remain with respect to **§103(a)** rejection.

Regarding Claim 2, Examiner states that Hampton's motor is an AC PMSM as explained in OA section 6 above. This is clearly incorrect. Hampton does not teach what is relied upon by Examiner in basing a **§103(a)** rejection of dependent Claim 2. Hampton clearly teaches a DC motor which is controlled by pulse width modulation. The novel and non-obvious control of **both** pulse width

and fr quency as in parent Claim 1 and Claim 1 (amended) can only apply to an AC PMSM pump (Claim 2) and not the DC motor pump of Hampton et al. It is further noted that the diaphragm pump in Hampton has neither a rotor nor an impeller and therefore Hampton does not teach what is additionally relied upon to base a **§103(a)** rejection of Claim 2. Claim 2 is clearly allowable over Hampton et al.

Regarding Claim 3, examiner states that "a rigid coupling is required for almost all motor/pump systems." Hampton et al. teaches a diaphragm pump having *neither a rotor nor an impeller*. The Hampton motor is rigidly coupled to an eccentric which drives the diaphragm via a rod (see Hampton Fig. 1). Under **§103(a),** the rotor impeller/ assembly in Claim 3 would require the rotor to be rigidly coupled to the pump *motor* which would render the AC PMSM pump of the applicants' Claim 3 inoperative. Hampton et al. does not teach what is relied upon in the OA to base a **§103(a)** rejection of Claim 3.

On the basis of **§103(a)** rejection, the majority of AC PMSM have impeller/rotor assemblies with a limited-motion engagement coupling; these couplings allow up to one-half turn of free (non-rigid) impeller rotation with respect to the rotor. Without limited-motion couplings, these AC PMSM pumps would simply not start reliably, if they would start at all. Claim 3 is non-obvious as it teaches away from the prevailing AC PMSM art.

Regarding Claim 8, Examiner states that in Hampton "the setting of timer 118 (such as rotary wheels) is a line receiver/transmitter interface." This constitutes a strained interpretation of "line receiver/transmitter" as enunciated in Claim 8. Note that timer 118 in Hampton et al. is simply provided to turn the pump on at predetermined intervals (that is, one sets an interval value on the timer and the timer - which could be a cam-operated relay - then periodically

activates the pump). It is not obvious to "extrapolate" the **one-way** timer 118 in Hampton et al. into the **two-way** line receiver/transmitter in Claim 8 for interfacing a two-way (receive/transmit) input to a micro-controller. Claim 8 is clearly allowable over Hampton et al.

7. Rejection of Claim 12 §103(a) Over Hampton et al. or Slate et al. is Overcome (OA section 8)

Claim 12 has been amended to depend on amended Claim 1. This overcomes Examiner objection to Claim 12 as having the same subject matter as un-amended Claim 1 since Claim 12 is now written in dependent form. Amended Claim 12 also contains language to more clearly enunciate the coupling of the fountain to the apparatus in amended Claim 1.

Regarding **§103(a)** rejection of Claim 12, Examiner states that a "fountain element together with a motor" is well known art. Examiner sites no prior art as a basis for this position. It is not "well known art" nor would it be fruitful to directly couple a fountain element to an AC synchronous motor pump to obtain a variable water pattern, as such coupling without reading on Claim 1 would yield *constant* flow and *not* the desirable *variable* flow patterns of Claim 12.

Examiner states that "it would have been obvious to a skilled person in the art to use the Slate or Hampton motor and controller to control a fountain element in a fountain to achieve the same subject manner" as enunciated in Claim 12. Slate et al. teaches an intermittently driven piston pump; this would be wholly inappropriate to drive a fountain as enunciated in Claim 12 or for that matter any fountain designed for generating variable output flow patterns. Hampton teaches a diaphragm pump also designed for intermittent operation (timer 118), however

in air. To the applicants' knowledge diaphragm pumps have not been us d in liquid fountain applications since even if driven continuously, they would tend to give a pulsed output even at a fixed drive speed.

In both Slate and Hampton, feedback controllers are employed to control their respective pumps. These controllers cannot cause a variation in output of an AC PMSM pump as in Claim 12.

Based on these arguments, applicants contend that the fountain and fountain element in Claim 12 (amended) are allowable subject matter under Slate et al. or Hampton et al.

Applicants respectfully request that Examiner does not make a restriction requirement dividing Claims 1-12 into two groups. If however, Examiner decides to impose a requirement for restriction of invention, then he is authorized by applicants to cancel Claim 12.

8. Regarding Drawing Correction (OA section 9)

In "A special message from the examiner", Examiner requires labeling of boxes in Fig. 1 with descriptive titles. Applicants are implementing Examiner's requirement by the proposed drawing changes to Fig. 1 submitted with this amendment.

Applicants note that the box identified as "170" in Fig. 1 has been inadvertently mislabeled and should have been labeled "270". Label 270 is specified in the disclosure as a potentiometer and is the correct numeral to describe the box in question. There is no reference numeral "170" in the disclosure. The proposed drawing change is shown on Fig. 1, submitted with this amendment, wherein numeral [170] is replaced by numeral 270.

9. Request for Reconsideration

Applicants have reviewed references cited in the OA but not relied on: Arvidson et al. (US-RE-35,362), Kaffka et al. (US-4,705,216), Alba (US-4,844,341), Alba (US-5,069,387), Ting (US-6,206,298) and Hall (US-6,276,612). These references do not show applicants' invention or render it obvious.

Claim 1 was amended to further enunciate the unique features of the invention, to further differentiate from the prior art and to more specifically overcome §102(b) and §103(a) objections based on Hampton et al. and Slate et al.

Claim 2 was amended to correctly refer to amended Claim 1

Claim 3 was amended to correct problems of antecedent base.

Claim 4 was amended to depend on amended Claim 1.

Claim 7 was amended to correct problems of antecedent base.

Claim 8 was amended to correct problems of antecedent base. Arguments were also forwarded to overcome §102(b) and §103(a) rejection.

Claim 9 was amended to correct problems of antecedent base.

Claim 10 was amended to correct problems of antecedent base.

Claim 12 was amended to further enunciate the unique features of the invention. Applicants request that if Examiner decides to impose a requirement for restriction of invention, then he is authorized by applicants to cancel Claim 12.

Claim 13 was written to correct problems of antecedent in un-amended Claim 9.

Claim 14 was written to enunciate the manner of calculation of motor pump voltage and frequency for varying the flow rate of an AC PMSM.

Claim 15 was written to enunciate the simultaneous and r lated variation of the voltage and frequency of an AC signal applied to an AC PMSM for extending the attainable range of pump flow rates.

Proposed drawing changes to Fig. 1 have been made and are submitted with this amendment.

10. Conclusions and Request for Claims Drafting Assistance

Based on the arguments forwarded by the applicants to counter Examiner objections, based upon changes to the claims to more clearly enunciate the features of the invention, based on changes made to specifically address Examiner objections, the applicants submit that amended Claims 1, 2, 3, 4, 7,8-10 and 12 are clearly allowable over the cited references and solicits reconsideration and allowance.

It is also respectfully submitted that new dependent Claim 13 be considered for allowance since it simply corrects an antecedent problem in the un-amended Claim 9.

It is submitted that patentable subject matter is clearly present as elucidated in the amended claims and new Claims 14 and 15.

If the Examiner agrees that patentable subject matter is clearly present but does not feel that the present claims are technically adequate, applicants respectfully requests that the examiner write acceptable claims pursuant to MPEP 707.07(j).

Very Respectfully,

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I hereby certify that this correspondence and attachments, if any, will be deposited with the United States Postal Service by Express Mail # ET556956586 US, postage prepaid, in an envelope addressed to: Box Non Fee Amendment, Commissioner for Patents, Washington, D.C. 20231 on the date below.

Date: 17 JULY 2002

Inventor's Signature: *Chris S. Brunt*